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Fishery Leaflet 55

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PACIFIC OCEANIC FISHERY
INVESTIGATIONS

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BREATHING IN FISHES

Prepared in the Division of Fishery Biology

Fishes must breathe, that is, respire, in order to live because respiration is indispensable in the maintenance of life of both aquatic and air-breathing animals. As the living parts of animals use oxygen and produce carbon dioxide constantly, the two principal functions of respiration are the same for all animals. Respiration must furnish the blood an adequate and continuous supply of oxygen, and must remove unneeded carbon dioxide from the blood. This exchange of gases as it is termed, that is the inflow of oxygen and the outflow of carbon dioxide, is often quite large especially when the animals are active.

The actual mechanisms of respiration vary widely with different groups of animals. Many land animals including man have lungs through the moist membranes of which the blood can absorb oxygen from the inhaled air and unload carbon dioxide into the air which is exhaled. Most fishes however obtain their oxygen from the small quantity of oxygen gas dissolved in the water. Two sets of gills instead of lungs accomplish this. These gills are composed of many rows of fine filaments each of which contains several loops of tiny capillaries which carry the blood close to the surface of the filament. The filament is covered by a layer of living tissue so thin that the entire gill appears red because of the contained blood.

Each set of gills is protected by a cover, often bony in structure, which is attached in front to the side of the fish's head, but is free behind. The floor of the mouth opens onto the gills, and by alternately opening and closing the mouth and gill covers the fish pumps a stream of water through the mouth, over the gill filaments and out of the gill chambers. The blood in the gill filaments absorbs the needed oxygen from, and discharges the unwanted carbon dioxide into this water. The regular movements of the gill covers and the mouth correspond in effect to the breathing movements of man.

Many fishes swim with their mouths open so that when the fish is moving a continuous stream of water passes over the gills. Very active fishes like the mackerel often die if confined in close quarters where they cannot swim rapidly as the movements of the gill covers alone do not bring in sufficient water for their respiration. Some fish when placed in water containing little dissolved oxygen come to the surface and take bubbles of air into their mouths to increase the amount of oxygen in the water passing over their gills. Fishes will suffocate in water which does not carry enough dissolved oxygen. Strange as it may seem, in such cases, they may be said to have drowned.

The fact that fishes require oxygen in order to live is of great practical importance to the fisheries. Fishes will not thrive in water containing insufficient oxygen and will die if the dissolved oxygen is severely reduced. In such cases it is of importance to discover the cause of the oxygen deficiency.

It sometimes happens that fishes die in great numbers during the winter in lakes and ponds covered with ice, for the ice prevents the reaeration of the water by direct absorption from the air. These deaths occur when the dissolved oxygen has been reduced to a very low level either by the respiration of the fishes themselves or by other aquatic organisms or substances which take oxygen out of the water. Unless the winter is very long or the fishes too abundant, there is usually enough dissolved oxygen in the waters of ice-covered lakes to meet the ordinary winter requirements of fishes, as fishes are less active in cold weather and consequently use less oxygen, and as cold water will carry more dissolved oxygen than warm water.

Various species of fishes not only possess gills but have special structures for breathing air, called accessory respiratory organs. In some fishes the air bladder or swim-bladder is connected with the mouth or otherwise modified to function to a limited extent as a lung. In the United States the fresh water gar and the bowfin have modified air bladders which enable them to supplement their gill respiration by gulping air when at the surface of the water. The lung-fishes which are natives of Australia, South America, and Africa are capable of breathing air into a lung-like structure enabling them to live in warm, muddy, and even foul waters in which other fish depending solely upon gill respiration cannot survive.

The special accessory respiratory structures of certain fishes are connected with the gill cavity. An example is the paradise fish, a native of China now commonly kept in this country as an aquarium fish. The climbing perch which live in tropical Asia, also have highly developed accessory structures for respiration and are able to remain out of water for several days in moist situations, even travelling some distance across land from one stream to another.

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Note: This leaflet supersedes Memorandum I-109, issued by the former Bureau of Fisheries.